PERCEPTION THRESHOLDS FOR LATERAL VIBRATION AT THE HAND, SEAT, AND FOOT

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Introduction

Discomfort, annoyance, or interference with activities due to exposure to vibration is only expected if the vibration exceeds the threshold for the perception of vibration. When there is more than one vibration input to the body (e.g. at the hands, seat and feet), the sensation is first experienced at the location with greatest sensitivity. Knowledge of differences in the thresholds of perception for vibration at the hand, seat, and feet should assist the identification of sources of discomfort caused by vibration.

Perception thresholds for vibration have been determined in several studies, but only a few studies have investigated perception thresholds in the horizontal direction for hand-transmitted vibration [1, 6] or whole-body vibration [4-5], and there has been little consideration of perception thresholds for the foot resting on a vibrating surface.

This study determines absolute thresholds for the perception of sinusoidal lateral vibration, examining the effect of vibration frequency (8 to 315 Hz for the hand and foot; 2 to 315 Hz for the seat) and the effect of input location (the hand, the seat and the foot).

Methods

Three groups of twelve males aged between 20 and 29 years participated in the experiment. Subjects in each group attended an experiment to determine perception thresholds for lateral vibration via either a rigid handlebar (30 mm diameter) at the left hand (left hand), or a rigid contoured seat (250 mm x 150 mm), or a footrest at the left foot (30.5 mm x 10.5 mm with 10-degree inclination). For the non-exposed hand (right hand) or foot (right foot), a stationary handle and footrest with the same dimensions as the vibrating handle and footrest were provided so that the same body posture was adopted among the three groups of subjects.

An up-down (staircase) algorithm was employed to determine thresholds in conjunction with a three-down one-up rule. A single test stimulus (2.0 seconds) was presented with a cue light illuminated during this period. The task of the subjects was to indicate whether they perceived the vibration stimulus or not. The threshold was calculated from the mean of the last two peaks and the last two troughs, omitting the first two reversals.

Results

The median absolute thresholds of the 12 subjects determined at each frequency for the hand, seat and foot are shown in Figure 1. A frequency dependence of the threshold contours within the investigated frequency range is evident, with similar shape to the threshold contours determined in other research [3-6]. Among the three locations (hand, seat and foot), the thresholds between 25 and 63 Hz did not differ significantly. The seat was the most sensitive to lateral vibration at 8 and 10 Hz among the three locations (Mann-Whitney, $p<0.05$). The hand was less sensitive to lateral vibration than the seat and foot at 12.5, 16 and 20 Hz (Mann-Whitney, $p<0.05$), but more sensitive than the seat and foot at frequencies greater than 100 Hz (Mann-Whitney, $p<0.05$).

Discussion

It is evident from Figure 1 that the vibration threshold contours derived from the present study are inconsistent with the reciprocals of the relevant frequency weightings (e.g. W_h, W_b, and W_d) in current standards [1-2], indicating greater sensitivity at high frequencies relative to low frequencies than implied by the standards for predicting perception thresholds at the hand, the seat, and the foot.

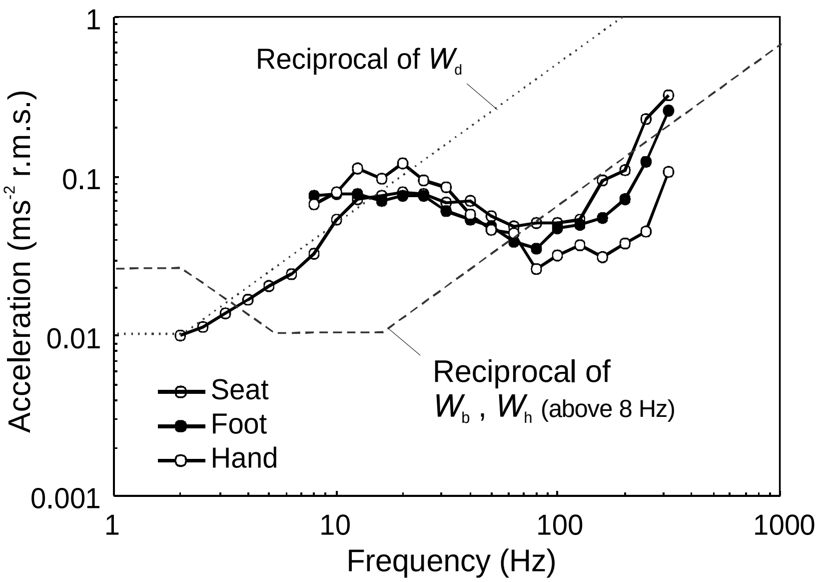

Figure 1 Median perception threshold contours for lateral vibration at the hand, seat and foot. The reciprocals of W_b, W_d, and W_h frequency weightings [1-2] normalized to 0.01 ms^{-2} r.m.s. are overlaid.

References

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